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NEW RECORDS AND NOTES ON THE BIOLOGY OF FROGS FROM NORTH-WESTERN AUSTRALIA

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INTRODUCTION

The North-West Province of Western Australia (see Fig. 1) is little known herpetologically. Mr. L. Glauert, Director of the Western Australian Museum, appears to have been the first herpetologist to visit and record collections from the area (Glauert, 1923), and during a subsequent visit he made collections of frogs among which was the new genus *Glauertia* (Loveridge, 1933). The only other local collector to visit the area before recent years was apparently the late Professor G. E. Nieholls. Some at least of his material was studied by Loveridge (1935) and Parker (1940).

During the last few years the following naturalists have collected frogs in various parts of the region:—W. Baggs and A. Snell, 1951; W. H. Butler, 1956; J. H. Calaby, 1955; A. M. Douglas, 1955; E. H. M. Ealey, 1954, 1956; E. P. Hodgkin, 1954; A. R. Main, 1953; W. B. Malcolm, 1955. These collections total approximately 50 specimens and contain several species not included in Main (1954), but none is undescribed. New data consist of range extensions and biological observations and these are the principal contributions of the present paper.

TAXONOMY AND BIOLOGY *HYLA RUBELLA* Gray

Specimens

Wittenoom: 2. iii. 1954 (E.P.H.); ♂ ♂ 3. Rudall River, 4 miles downstream from Watrara Pool; 15. ix. 1955 (J.H.C.); ♂ 1, ♀ 1. Woodstock Station; June, 1954 (E.H.M.E.); ♂ ♂ 4.



Fig. 1.—Localities mentioned in the text.

This frog is common and widespread in the region. The webbed feet, and fingers and toes with adhesive discs (Fig. 2a, b) make it an easily recognizable frog. Dorsally it may be brown, fawn, or pale grey with dark brown or black flanks. The length from snout to anus ranged from 26.5 mm. to 31 mm. for the males and was 33.5 mm. for the female.

Biology

The female collected on September 15, 1955, had well developed ovaries.

One of us (J.H.C.) saw and heard the frog calling at the following places:—Middle Branch of Gascoyne River (ca. 120 miles N.N.E. of Meekatharra) on September 7, 1955; on Caramulla Creek at Well 43 (ca. 30 miles N.N.E. of Mundiwindi) on September 8, 1955; on the Oakover River (ca. 40 miles N.E. of Balfour Downs homestead) on September 10 and 29, 1955; on the Rudall River from 4 to 16 miles downstream from Watrara Pool on September 15 to 17, 1955.

Previous authors record specimens from beneath stones (Loveridge, 1935; 42) and in a vegetable garden and a covered spring (Glauert, 1945; 379). The Wittenoom specimens were taken from rocks beside a large permanent pool. The Rudall River area is a completely wild situation untouched by European settlement. Here the frogs were common in long green seeding grass

on the banks of the river near pools. Others were up trees and were calling from here. The frogs were active and were climbing around in grass in the daytime. They came to lights in the camp on warm nights.

The call is a fairly loud wheezing sound not unlike that made by the Silver Gull (*Larus novaehollandiae*). The individual call is approximately 2 seconds in duration with a repetition rate of about 30 per minute. The individuals heard calling rarely called more than 5 or 6 times and were much more vocal on warm nights.

The principal rainfall of the region occurs between November and April and the foregoing observations are consistent with the frog being a summer breeder. Eggs and larvae have not been seen but Dr. Hodgkin procured a four-limbed larva from Kalumburu (Kimberley region) on March 12, 1954, which was 28 mm. long including tail, and 16 mm. from snout to anus.

Food habits

The Rudall River specimens contained a small flying Curculionid beetle, a small unidentified flying insect, and sand grains.

UPEROLEIA MARMORATA Gray

Specimens

Cape Range; June, 1955 (A.M.D.); ♂♂3, ♀♀2 (W.A. Museum nos. 11530-11534).

In life and shortly after being placed in preservative these frogs were a dark brown colour dorsally with a light bright brown triangular interorbital mark and spots of the same colour on the dorsum. After some time in preservative the bright patches tend to fade to dirty white. The dorsal colour of the live animals was suggestive of *Glauertia russelli* Loveridge and *Pseudophryne occidentalis* Parker but the specimens lacked webbing on the toes of the feet and therefore were not *G. russelli*. External examination showed in several specimens what appeared to be the ring of the tympanum beneath the skin immediately anterior to the parotid gland. It was then concluded that the specimens could not be *Pseudophryne*. However, no dissection has been made to check the presence of an inner ear or the absence of the fronto-parietal foramen, both positive characters of *Uperoleia*. The belly of all specimens was bodily mottled in black and white. The right hand and foot are shown in Figs. 2e, d. In length, from snout to anus, the specimens range from 24.5 to 30.0 mm.

Three specimens of *U. marmorata* from the vicinity of Sydney, identified and forwarded by Mr. A. Colefax of the University of Sydney, differ somewhat from the specimens above in several respects. The light dorsal spots are less distinct, the spot on the forearm and hinder aspect of the thigh is brighter and yellow, the parotid glands are larger, the tympanum is hidden, and the belly decidedly darker with less white.

Biology

Mr. A. M. Douglas, who collected these specimens, provided the following information on the habitat and biology. The frogs

were taken from under stones in a spring at the bottom of a talus slope in a steep-sided canyon. The spring fed a stream about 30 yards long containing only three pools. The area is one of limestone rocks and most of the drainage is sub-surface. He was attracted to the vicinity of the spring by the call of the frogs which he describes as "a harsh Ahk . . . ahk . . . repeated." Eggs were associated with the frogs. These were between 4 and 5 mm. in external diameter and contained fully developed larvae. Small tadpoles were present in the stream, which had probably only recently hatched from the eggs mentioned above. Unfortunately neither eggs nor tadpoles were returned with the adult frogs.

GLAUERTIA RUSSELLI Loveridge

Specimens

Weeli Wolli (Marillana Station); Nov., 1953 (A.R.M.); ♂♂ 3, juv. 3. Lyndon Station; June, 1951 (W.B. & A. S.); ♀♀ 4.

For many years this frog was known only from the type locality, Landor Station on the Gaseoyne River system. The two additional localities indicate that it is probably widely distributed.

The additional specimens agree with the description in Parker (1940, p. 66). As already mentioned when discussing *Uperoleia* the light brown or orange red spots on the dorsum are confusing, but *Uperoleia* is readily distinguished because of the free toes. The right hand and foot and the long narrow tongue are shown in Figs. 2 e, f, g. Juveniles range from 14.5 to 17 mm. in length from snout to anus, males from 24.6 to 27 mm. and females 27.5 to 31.6 mm.

Biology

The specimens from Weeli Wolli were heard calling at night beneath dead fallen reeds beside a permanent water hole. The call was a short grating squelch "Qrk . . . Qrk"—very similar to *Pseudophryne* and some of the *Crinia* species. None called during daylight. Mr. W. Baggs reports that the females from Lyndon were taken under abnormal conditions in June, 1951, when 9½ inches of rain had fallen between June 5 and 7 and produced widespread flooding. Specimens were found around the shearing shed and under flood rubbish. Frogs were most abundant on the evening of the 7th.

Food habits

Loveridge (1933: 89) describes this frog as being myrmecophagous. It is therefore interesting to record the variety of animals present in the diet of the animals examined (Table 1).

LIMNODYNASTES SPENCERI Parker

Specimens

Abydos Station; 18. i. 1956 (E.H.M.E.); ♂♂ 6, ♀♀ 4.

This species was formerly recorded only from Central Australia (Parker, 1940).

All specimens agreed with Parker's description. Vomerine teeth behind choanae. First finger not opposable to remainder. This species can be readily distinguished from all others so far collected from the region by the oblique vertical truncation of



Fig. 2.—Specific characters of: *Hyla rubella*, a, foot; b, hand. *Uperoleia marmorata*, c, hand; d, foot. *Glauertia russelli*, e, hand; f, foot; g, tongue. *Limnodynastes spenceri*, h, side view of head; i, hand (nuptial asperities stippled on thumb and first and second fingers); j, dorsal view of head; k, tongue. *Cyclorana cultripes*, l, hand (nuptial asperities on thumb only); m, foot; n, tongue; o, dorsal view of head. *Cyclorana platycephalus*, p, hand; q, foot; r, dorsal view of head; s, tongue. Right hand and foot figured in all cases.

the snout when viewed in profile and the minute spicules which cover the dorsum. *L. ornatus* from Fitzroy River (Kimberley region) has a similarly truncated snout but lacks the dorsal spicules.

Preserved specimens are grey with indistinct darker mottling. Mr. Ealey recorded the colour in life as rich golden yellow. The profile of the head and the right hand are shown in Figs. 2 h, i, and the shape of the head and tongue in Figs. 2 j, k. The belly and throat of females is a dirty white while the male has a white belly, dark throat and nuptial pads. In length from snout to anus males range from 36.5 to 44 mm., females from 35.5 to 42.0 mm.

Biology

The above specimens were taken at night along with *Cyclorana cultripes* after heavy rain associated with a tropical cyclone. Mr. Ealey describes the male call as being like "the call of a clucky hen." Claspings pairs were seen on sand adjacent to water and in water. A female which was not claspings when caught and placed in formalin, and because of the distention with eggs was believed not to have shed eggs before capture, contained a total of 1,128 eggs. These had a yellow yolk and black animal pole and were approximately 1.5 mm. in diameter, slightly larger than those of *C. cultripes*.

Food habits

An analysis of the stomach contents of 9 specimens is given in Table 2.

CYCLORANA CULTRIPES Parker

Specimens

Woodstock Station; June, 1954 (E.H.M.E.); juv. 2. Abydos Station; 18. i. 1956 (E.H.M.E.); ♂♂7, ♀♀4. 20 miles S. of Mia Mia; June, 1954 (E.H.M.E.); juv. 1.

This species was formerly known from western New South Wales and the Northern Territory (Parker, 1940). Parker states that it also occurs in northern Western Australia but does not record any specimens from here.

This species is distinguished from *Limnodynastes* by the opposable first finger and the vomerine teeth between the choanae. Chin of calling male dark. Right hand and foot as in Figs. 2 l, m and tongue as in Fig. 2 n. The pointed narrow head of this species (Fig. 2 o) readily distinguishes it from *C. platycephalus* (Fig. 2 r). The dorsum of preserved *C. cultripes* is mottled in darker and lighter grey with a rather distinct lighter mid-dorsal line. Mr. Ealey describes the colour in life as pinkish at night, dark brown by day, while *C. platycephalus* is rather a uniform golden brown.

In length from snout to anus males range from 33.7 to 41.0 mm., females from 37.4 to 39.0. Juveniles from Woodstock were 19.2 and 19.5 mm. while that from Mia Mia was 28.8.

Biology

Eggs measured approximately 1.2 mm. It was not possible to identify an undoubtedly unmated female so no attempt was made

to count the number of eggs present. The call is a repeated "Baa . . . baa . . . baa . . .," rather like a sheep bleating.

Food habits

An analysis of the stomach contents of 12 specimens is given in Table 3.

CYCLORANA PLATYCEPHALUS Gunther

Specimens

North-West Coastal Highway, 10 miles S. of Minilya River; June, 1954 (E.H.M.E.); juv. 4. Winning, just S. of; June, 1954 (E.H.M.E.); juv. 1.

In Western Australia this species was formerly known from Dalgaranger (Loveridge, 1935).

Readily distinguished from *C. cultripes* as already discussed. Right hand and foot, head and tongue as in Figs. 2 p, q, r, s. In the laboratory live specimens are a rich golden brown with an irregular brown pattern of darker blotches. Spencer (1896) figures a specimen (as *Chiroleptes platycephalus*) and mentions its brilliant colours in the breeding season. The length from snout to anus of the juveniles ranged from 33 to 44.6 mm. Parker (1940) gives 56 mm. and 68 mm. as the lengths for adult male and female respectively.

DISCUSSION

It is noteworthy that in the stomachs of the two species of frogs collected on the surface after heavy cyclonic rain (*L. spenceri* and *C. cultripes*), termites outweighed other food items both in bulk and number of individuals. These were mainly alates but soldiers and workers were represented in some samples. This is no doubt due to the fact that the weather conditions favourable for the breeding and feeding of frogs in arid Australia are also those which precipitate colonizing flights of termites. A fair number of ant alates were represented and these also swarm during similar weather conditions.

One would expect that worker ants, and workers and soldiers of those species of termites which forage for food on the surface would provide food for frogs in inland Australia. One each of the specimens of *G. russelli* and *C. cultripes* contained such termites, *Drepanotermes rubriceps* in both cases, and many specimens contained worker ants. We have data (unpublished) on frog stomachs from other parts of Western Australia which also contain such termites. Surface foraging termites are numerically abundant in the North-West, in the genera *Drepanotermes*, *Nasutitermes* and *Tumulitermes*, and ants are a dominant faunal element. All of the termites named down to species are known from the area and most are very common (J.H.C., unpublished data).

Several cases were recorded in which the frog had eaten all castes of termite species of which the non-reproductive castes do not normally come to the surface (*Amitermes* n. sp., *A. perarmatus*, *Microcerotermes serratus*). In these cases the frogs must have

been close to the escape galleries during colonizing flights and snapped up the termites while they were emerging.

The wide variety of animals recorded in the diet of the frogs examined gives further substantiation to the fact that frogs generally are unspecialized opportunist predators and snap up anything moving of a size which they can swallow.

In addition to the species treated above, the following other frogs occur in the region: *Heleioporus wilsmorei*, Wurarga, N.E. of Yalgoo (Parker, 1940: 36); *Notaden nichollsi*, Rabbit Proof Fence No. 1, Far North (Parker, 1940: 64); *Crinia signifera* and *C. georgiana*, between Carnarvon and North West Cape (Parker, 1940: 87, 80); *Limnodynastes dorsalis*, lower reaches of Murchison River; *Heleioporus centralis*, Murchison River at Galena, and 40 miles S. of Carnarvon (both juvs.); *H. pelobatoides*, Murchison River at Galena (juvs.), and Monkey Mia, 15 miles E. of Denham (juvs.); *H. albopunctatus*, 20 miles N. of Murchison River near Galena; *Pseudophryne guentheri*, estuarine part of Murchison River (all A.R.M., unpublished data). Furthermore, *Hyla raniformis* might be expected to occur with *L. dorsalis* and *P. guentheri* on the lower Murchison River.

Thus the region has at least 15 species of frogs of which the majority have their main range to the south and only cross the southern boundary particularly along the Murchison River. *Glauertia russelli* is the only species restricted to the region but its generic affinities are Torresian. *Uperoleia marmorata* and *Notaden nichollsi* are Torresian species. *Heleioporus centralis*, *Cyclorana platycephalus* and *Limnodynastes speneeri* are Eyrean species while *Hyla rubella* and *C. eultripis* are both Torresian and Eyrean. The frog fauna thus appears to be a composite of Southern, Central and Northern elements, equivalent to the Vlaminghamian, Sturtian and Leichhardtian fluvifaunulae of Whitley (1947).

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TABLE 1
 Stomach contents of 6 specimens of *G. russelli*
 (In Tables 1 to 3, a. = alates, s. = soldiers, w. = workers)

Food item	Specimen no.					
	1	2	3	4	5	6
Termites: <i>Drepanotermes rubriceps</i> (Froggatt) <i>Microcerotermes</i> sp.	99 w.	4 w.	1 w.	large no. w	few w.	large no. w few w.
Ants: <i>Iridomyrmex</i> sp. (small) Myrmecinae Various small spp.		7 w.	large no. w			
Beetles: Unidentified larvae Unidentified small adults	1	1	4			5
Hemiptera: Coccidae			1			
Arachnida: Gnaphosidae <i>Lampona quinqueplagiata</i> Simon* Unidentified juv.			1 1			
Vegetable matter Sand grains		2 seeds v	v	v	v	stalk

* Kindly identified by Dr. B. Main.

TABLE 2
Stomach contents of 9 specimens of *L. spenceri*

Food item	Specimen no.								
	1	2	3	4	5	6	7	8	9
Termites:									
<i>Mastotermes darwiniensis</i> (Froggatt)									
<i>Amitermes perarmatus</i> Silvestri *				20 a., 7 s., 15 w.	3 a., 1 s.,		1 a.		
<i>Amitermes</i> sp. **		17 a.	4 a.	10 a., 3 s., 10 w.				1 a.	8 a.
<i>Microcerotermes serratus</i> (Froggatt)									
<i>Nasutitermes triodiae</i> (Froggatt)		2 a.	7 a.	9 a.		1 a.	3 a.	21 a.	15 a.
<i>Tumulitermes</i> sp.							1 a.		
Unidentified termites									
Ants:									
Many spp. from very small to large	4 w.	7 w.	2 a., 8 w.	3 a., 8 w.	1 a., 37 w.	8 w.	19 w.	5 a., 13 w.	11 a., 4 w.

* The alate caste of *A. perarmatus* is not known but there can be no doubt that the fragments of small dark, dark-winged *Amitermes* alates found in association with *A. perarmatus* soldiers and workers in these specimens, do in fact represent this species.

** It was not possible to identify these down to species as they cannot be matched with specimens of known species or descriptions. Unfortunately the majority of *Amitermes* species in arid Australia are known from soldiers and workers only.

TABLE 2
(Continued)

Stomach contents of 9 specimens of *L. spenceri*

Food item	Specimen no.								
	1	2	3	4	5	6	7	8	9
Beetles:									
Scarabaeidae	1								
Dynastinae								1	
Elatridae						4		2	
Carabidae								1	
Hemiptera:									
Reduviidae (nymphs)					2				
Dermaptera		1							
Crustacea:									
Armadillididae								3	
Vegetable matter		stalk				seed stalk			
Sand grains	✓	✓	✓	✓	✓	✓	✓	✓	✓

TABLE 3
Stomach contents of *C. cultripes*

Food item	Specimen no.											
	1	2	3	4	5	6	7	8	9	10	11	12
Termites:												
<i>Heterotermes ferox</i> (Froggatt)						1 a.						
<i>Schedorhinotermes intermedium</i> <i>actuosus</i> (Hill)		1 a.										
<i>Amitermes perelegans</i> Hill							6 a.					4 a.
<i>Amitermes</i> n. sp. *					12 a., 5 s., 2 w.	1 a.						
<i>Amitermes</i> sp. **		5 a.	2 a.					4 a.	5 a.		10 a.	
<i>Drepanotermes rubriceps</i> (Froggatt)								1 s.				
<i>Microcerotermes serratus</i> (Froggatt)						5 a.	3 a.			3 a.		
<i>Nasutitermes triodiae</i> (Froggatt)	13 a	2 a.	3 a.	3 a.				3 a.	11 a.	2 a.	5 a.	2 a.

* This new species is allied to *A. equito* Hill and is common in the area. The alate caste is not known but the alate fragments found in these specimens are no doubt correctly associated with the soldiers and workers. The alates are small and dark with dark heads and dark smoky wings.

** See under footnote ** to Table 2. In the *C. cultripes* stomach specimens four or five unknown *Amitermes* alates are represented.

(Continued)

Stomach contents of *C. cultripes*

Food item	Specimen no.											
	1	2	3	4	5	6	7	8	9	10	11	12
Ants:												
Ponerinae					5 w.				1 a.	3 w.		
<i>Iridomyrmex</i> sp.											2 w.	
Formicinae		2 a. 3 w.			1 w.		6 a. 2 w.	35 a.	6 a. 1 w.	1 a.		2 a.
Unidentified (several spp.)												
Beetles:												
Elatridae	1											
Orthoptera Saltatoria						1						
Dermoptera (winged)												
Diptera:												
Unidentified small flies								22				1
Arachnida:												
Lycosidae												
Unidentified juvenile										1		
Vegetable matter					seed							
Sand grains		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓